ANNUAL REPORT OF THE DEPARTMENT OF AGRICULTURE, GOVERNMENT OF MYSORE, FOR THE YEAR 1901-02.

STAFF.

The only change in the staff has been the addition of an Associate of the College of Agriculture at Saidapet, to assist in Plot Experiments and general office work. I must thank all in my Department for their willing and cheerful assistance, and wish to again mention the names of Mr. B. Venkata Rao, Assistant Chemist, and K. V. Krishnasami Iyer, chief clerk, as particularly praiseworthy in this direction.

THE WORK OF THE DEPARTMENT.

The work of the Department during the year may be divided into the following five heads :—

(*a*) Analytical work.
(*b*) Tours.
(*c*) The distribution of information on agricultural matters.
(*d*) Agricultural Experiments.
(*e*) The fitting of the remainder of the Laboratory.

Under the last of these headings very little need be said in this report notwithstanding that it absorbed a large portion of the time of the Agricultural Chemist. The nature of the work required for fitting a chemical laboratory is such that no one could be found in Bangalore to do it satisfactorily even after detailed plans had been prepared. The work which had been given out on contract last year was so badly done that a large portion of the fittings had to be taken out again by the Agricultural Chemist and his subordinate staff. After being trained in the work the Assistant Assayer did very well indeed, but of course required constant supervision. The principal part of the carpenter work was however done by contract and was done very satisfactorily indeed, especially after the contractor understood exactly what was required. Detailed plans had however to be made for everything by the Agricultural Chemist. Now that the laboratory is practically completed a short description of it may not be out of place, especially as it is practically the first Laboratory of its kind in India and can compare favorably with the average Agricultural Chemical Laboratories in other countries.

LABORATORY.

The distribution of space and the size of the various rooms may be judged from the accompanying ground-floor plan. The general Laboratory receives its light almost exclusively from the open court-yard in the centre of the building. It was feared at one time that this would make it a little dark. But it has all the light any one could desire. It is decidedly the coolest room in the building, probably on account of having other rooms to protect it on the east, south and west. The roof is tiled and lined with wood on the inside. The latter forms the ceiling of the various rooms, thus helping to make them even higher than the already high walls (19 feet) would make them. In the main Laboratory are three central working benches 11 feet long and 5 feet wide with earthenware sinks at each end. On the centre of each bench is a shelf for reagents and underneath this are 12 gas taps, all so arranged that the gas supply can be regulated from the front of the benches so as to avoid disturbing any apparatus which may be standing on the benches and blocking the way to the taps when regulating the gas supply to the burners. Over the sinks at each end of the bench is a triple water tap. The distance between the benches is 5 feet. Running along nearly the full length on one side of this Laboratory is a side working bench two and a half feet wide with goose neck water taps every 7 feet and a gass tap about every 22 inches. All the benches are 3 feet high. The top foot is provided with drawers of various sizes and the two feet at the bottom are, as is usual, closed in by doors and used as cupboards. At one end of the Laboratory is a wash up sink provided with hot and cold water, and drain boards, and bench space for the dirty glassware ; at the other end are the fume cupboards with large water bath and sand bath, a short bench and the still to supply the necessary distilled water. On the remaining side largely cut up by doors are cupboards for holding the apparatus in general use, chemicals and standard solutions and samples prepared for analysis. All the wood work is of teak finished in its natural colour and trimmed with blackwood mouldings. The tops of all the working benches are impregnated with paraffin to make these more resistant to alkalies and acids. The pipes, although laid in drains under the floor and concealed in the working benches, can be got at readily at any time. They were nearly all laid down by the Agricultural Chemist and his subordinates, as no competent man could be found to undertake the work. The fittings are nickel-plated brass. The nitrogen and potash rooms and the private laboratory are, barring a few changes, reproductions on a smaller scale of the main Laboratory. The apparatus and store-room has been built so that it can be easily converted into a laboratory if required. The principal windows are counterpoised sliding sashes fitted with plate glass. And the greater part of the floors is covered with a very hard, though not glazed, earthenware tile. The building is constructed of gray granite and is both comfortable and neat in appearance.

ANALYTICAL WORK.

During the year 105 samples were analysed. Of these fully one-half, *viz.*, 54 were received through the Geological Department. These kept the two assistants fully occupied. The samples comprised gold ores, minerals and samples of bar and sponge gold. Many of the analyses of the gold ores were done for private individuals and a fee was charged and collected for them by the Geological Department. The analyses of bar gold and sponge gold were virtually done for the Police Department and only sent in through the Geological Department. These requests for analyses of samples of gold supposed to be stolen from the Gold Fields are increasing and the amount of work entailed in the analyses is considerable. However, as a chemical analyses is practically the only means by which the Kolar gold can be identified, and as, thanks to the energetic work of the State Geologist, some of the Kolar gold can now be identified with absolute certainty by these analyses, this line of work deserves every encouragement in a State where the gold mining industry is such an important factor. The analytical results of the samples sent through the Geological Department will be published in the memoirs of that Department.

The remainder of the work (51 samples) were done for this Department, and are principally the work of the probationary assistant and myself. The samples are made up principally of sugars, fertilizers and soils and are published in part in the appendix to this report.

TOURS.

In all ten tours were made during the year and varied in extent from a few days to a little over a month. Those of only a day's duration are not of course considered as tours. They were for very varied purposes, the examination of lands of various kinds and for various purposes, the study of the sugar industry, to examine crops attacked by insects, to see the experimental plots of planters, and to see coffee in other parts of India, *viz*, Coorg and the Shevaroys. The information gained on the Coorg tour has already been partially published in Bulletin No. II of this Department. The tour to the Shevaroys was for the purpose of seeing the effect of cutting out every alternate tree on the estate of Mr. Leeming, the energetic planter who first practised and advocated this system.

LEEMING'S SYSTEM.

Every agriculturist seeing coffee, as generally grown in Southern India for the first time must be struck by the fact of its being crowded very much. Whether such crowding is necessary or not, or whether coffee will thrive and crop equally well per acre when not crowded so much and whether the soil can be kept in as good or better tilth when the coffee is not so crowded, are all questions which can be debated almost indefinitely. They have all their pros and cons, and in how far the one overbalances the other can only be proved by experiment. For absurd as it may seem to a casual inexperienced observer, the crowding system has something in its favor.

DISTANCE BETWEEN COFFEE.—No doubt coffee trees ought, like other plants, to grow a proper distance apart. And no doubt like in other plants there is some latitude in this distance for the same soil and the same climate. For example in sugar-cane practically the same yield of sugar was one year obtained per acre at the New Orleans Experiment Station when the rows were three feet apart and when double that distance, and the intervening distances give almost the same result. In this case we may say that 4½ feet apart was the proper distance, but by giving one and a-half feet either way we still got practically the same yield per acre. Similarly if we know the proper distance to plant coffee we should likely find that planting it a little closer or a little wider apart would make little difference in the yield per acre. But what is the right distance on one estate may not be the right distance for another estate. There is no doubt that on one field I have seen on which the coffee was, I think, planted 6 feet by 6 feet it was not overcrowded, while on another field in the same district planted practically the same distance apart there was no doubt of the coffee being overcrowded. In cases where coffee is crowded an attempt is sometimes made to atone for this by heavy pruning. Within certain limits this is no doubt effective. But undoubtedly it is expensive both on account of the extra labour involved and on account of the energy and plant-food wasted by the trees. Sometimes the overcrowding is however so great that even heavy pruning will not keep down the wood to the limits the space will permit. Instead of producing crop the trees run to wood. A deep digging may possibly check some of the tendency to produce wood by cutting off a lot of the roots and reducing the vigour of the tree. But there are fields on which even this check was not able to keep the trees within the desired limits. They still produced wood instead of crop. So far as my present experience goes it leads me to believe that the knife should be very sparingly used, and if trees require heavy pruning they are growing too close together. How far the branches of neighbouring trees should be permitted to touch each other it is difficult to say at present. This involves not only the subject of what is best for the tree itself as such but also the welfare of the soil; and the condition of the latter of course re-acts on the former. For the trees themselves it is probably of advantage to have them so far from each other that none of the branches of neighbouring trees touch each other. For the mechanical condition of the soil, it is however more than likely that the closer the trees the better. The soil will have more shade, more much and be less likely to become infested with grass. The benefit of these latter factors is not fully recognized as yet. Still it will be difficult to over-estimate them. Of course the fewer the number of trees the larger the crop from each individual tree must be to make up the same yield per acre. Just how far the trees should be

apart on a given piece of land to give the most favorable returns when considering all the factors experiments alone can show. They have shown us that in certain places the coffee is undoubtedly too crowded. But to judge from this that the coffee is overcrowded in all places would be a fatal mistake. For they have not even proved to us that it is overcrowded as a rule. And as it is easier to cut down a tree than to grow one, it would not be wise to experiment on too large a scale.

BORER.—Fears have been expressed by many that if the trees where further apart than they are as a general rule now, the borer would be likely to create more havoc among them. This may be the case shortly after the trees have been thinned out. But when they have grown that way for a year or two (provided of course that the need of thinning out was indicated by their vigorous growth) the trees protect their own stems to such an extent by the drooping branches which touch the ground that little fear need be entertained on this score provided the life history of the borer as generally accepted at present is correct. The stem will be even more perfectly shaded by its own branches than it was before notwithstanding that its neighbour is removed.

MANURES, CULTIVATION, SUCKERS, BRANCHES.—These and other subjects are often discussed in conjunction with that of growing coffee further apart. They require to be experimented with much more than has been done at present before anything which deserves to carry weight can be said about them in this connection. I cannot see how the distance between the trees can have any influence upon the quantity of manure which ought to be applied, provided the same crop of coffee per acre is expected. Cultivation is made easier on the one hand by the trees being further apart but on the other hand the branches being so much lower makes it more difficult. Furthermore as has been proved in Coorg, the stirring of the soil is, to say the least, not necessary as a rule if the coffee is close enough to cover the ground. Trenches are supposed to have given marvellous results. Why they should do so it is difficult to say, except that the earth thrown out may possibly act as a mulch. If that be the case the natural mulch of leaves, if it exists, is doubtless much better than the mulch of earth thrown out of the trenches. By making the latter the planter will lose his mulch of leaves for the time being to a large extent and produce an uneven surface and thereby prevent a uniform distribution of his mulch of leaves (a very important matter) for sometime to come. Where surface wash exists and the trenches are used to catch this their beneficial influence can of course be easily explained. If under the existing circumstances on any particular estate they are really showing beneficial results of course well and good, and I sincerely hope that we may find out the cause for this beneficial result so as to be able to apply the trenches intelligibly. For it is not likely that trenching can be practiced under all circumstances with success.

FERTILIZERS.

The agriculturist in Mysore realizes, no doubt, that manures are of great value to him. He prizes the cattle manure very much and collects various natural fertilizers such as the leaves and flowers of the Hongay tree for manurial purposes. He carries into his cultivated fields (principally his arecanut plantations) jungle soil or any other kind of soil he can secure free of cost both for the manurial value he believes it to contain and for covering up the roots of the palms which may have been laid bare by the washing away of the original soil. The better educated and more prosperous agriculturists make use of various oil cakes and to a more limited extent of bone meal. But which the exception of the planters the other commercial fertilizers are practically unknown, or at least unused.

Plants require foods just as animals do, only the food is of a different kind. The soil is among other things a store-house for plant-food, and in common with other store-houses will become exhausted in time if we do not return to it the plant-food removed from it. The substances replacing this plant-food are called manures. Few of these manures supply everything the plant requires to make it grow. But most soils contain some of the plant-food which is required in small quantities by the plant, in such relatively large quantities that the supply they contain is practically inexhaustible, as for example, iron, and we do not require to consider this kind of plant-food at all when speaking of manures. Generally there are three or four kinds of plant-food of which the soil is liable to contain a comparatively small quantity and which as a result we must be ready to supply in the form of manure when needed. These substances which are called, Nitrogen, Phosphoric acid, Potash and Lime can be separated out of the soils and out of the manures by Chemists, and these people can therefore tell us to a certain extent what the soils are deficient in and what fertilizers must be applied to give the best results. For the soils are not all alike and the plant-food one soil may be particulary deficient in, an other soil may have in sufficient quantity for immediate use. Also the manures have not got these substances in equal quantities. One kind of manure contains a particularly large supply of one kind of plant-food, another has principally another kind of plant-food which it can supply to the soil. One manure may give large crops on one field to which it supplies just the kind of plant-food which is missing, while it will fail to produce an equally good crop on another field no matter how much of it may be applied, if it does not contain that kind of plant-food which is required for that particular field. For this and other reasons these one-sided or special fertilizers are not used much in countries in which agricultural chemists have not been at work. As a rule only such manures find favor there which supply all the plant-foods which are likely to be wanting on an average soil. We may therefore call these manures complete fertilizers to distinguish them from the one-sided or special

fertilizers which supply principally one or, at most, two kinds of plant-food. These complete fertilizers are generally excreta from domestic animals. In such, the different kinds of plant-food are generally present, only in small quantities, and not always, in the proportion in which they are required by the crop on a certain soil. As a result, these manures may often be mixed with small quantities of special fertilizers to great advantage. For, this small quantity of special fertilizer is supplying what happens to be deficient in the general fertilizer, and it having a comparatively large percentage of this one constituent is equivalent to a large quantity of the general fertilizer with which it is mixed. For example, if a soil happens to be greatly deficient in phosphoric acid, one pound of bone meal which contains 20 per-cent of phosphoric acid may be 50 times as valuable as a cattle manure containing 0·4 per cent of phosphoric acid. Or if the soil happens to be particularly deficient in potash one pound of ashes containing 5 per cent of potash may be equal to 25 lbs. of manure containing in addition to 0·2 per cent of potash 0·4 per cent of phosphoric acid and 0·5 per cent of nitrogen. For the latter not being required would be practically valueless. If however the soil were equally deficient in both these constituents and nitrogen as well, no amount of ashes or bone meal would do much good by themselves. It would require ashes *and* bone meal and poonac as well. In that case about one pound of bone meal, two pounds of ashes and four pounds of poonac, would contain the plant-food found in 50 lbs. of cattle manure having the composition given above. Therefore even if all the constituents of plant-food supplied by cattle manure are deficient in the soil we may still, to a large extent, re-place or augment cattle manure if we desire to do so. There are of course other special manures which may re-place those mentioned above. Saltpetre may take the place of the ashes and to a certain extent that of poonac as well. Fish manure may re-place poonacs, also bone meal though it does not possess as high a percentage of phosphoric acid as the latter. Blood manure may also be used instead of poonac and is more concentrated than it. Besides these, there are a lot of imported fertilizers which may be used. So that the agriculturist has in addition to the manure he produces in his own stables, a large number of commercial fertilizers to draw from should he desire to augment his supply of manure; and money judiciously spent in buying fertilizers is generally well spent. However when buying any fertilizers the purchaser ought to know exactly what he is buying. Fertilizers even of the same kind vary very much as will be seen by comparing the analysis of some of these fertilizers as found in the appendix. In each case, therefore, purchasers should try to get a guaranteed analysis indicating the quality of the fertilizer they intend to buy before investing their money.

The raiyat is not likely to spend any large amount of hard earned money in manures. He has less of it than many of his brother agriculturists in other parts of the world, and though he prizes cattle manure very highly and collects some other manures such as Hongay leaves and flowers (for which he does not require to pay) he does not value manures as highly as many of his brethren in other countries, and much as cattle manure is valued, the care bestowed upon it is very imperfect.

CATTLE MANURE.—In Mysore two systems of collecting this manure exist. In the one the stables are cleaned out daily and the manure placed in a heap or a pit; in the other, the manure is allowed to accumulate in the stables. But in neither case is bedding or litter used to any considerable extent and as a matter of course the urine must be lost very largely, if it does not drain away entirely. Of course, the relative amount and relative composition of the dung (the solid excreta) and of the urine (the liquid excreta) vary very much with different feeding. But on an average, with well fed cattle, the quantity of plant-food excreted in the urine is about the same as that excreted in the dung as determined by Messrs. Muntz and Guard in their experiments in Normandy. About half the quantity of the plant-food of the manure is therefore lost if the urine is not preserved. In fact, probably a little more than half. But so far as the quality of plant-food is concerned the loss is several times as great. Probably, if applied directly to the field in suitable dilution, the urine produced by a herd of mature cattle would be say, four times as valuable as the dung, for in the urine the nitrogen is directly available for the plants, while in the dung it is comparatively inert. Perhaps one practical illustration from actual agricultural practice may serve to bring home this point with greater force. A farm well known to me, on which practically all the urine was allowed to go to waste formerly, has increased its average yearly crop returns for the past ten years by 300 per cent since carefully preserving all the urine in its stables, and that of course without increasing the expense of cultivation. In order to save this urine it is necessary to resort to one of two principles, either to have water-tight floors for the stables and collect the urine in cisterns or water-tight pits, or to use enough bedding or litter to completely absorb the urine. The former principle though used in parts of Europe will, I fear, not answer well in this climate. For the latter purpose very varied substances may be used as absorbents; straw, dry earth, dry leaves, or dry ferns will answer. Straw is the material most extensively used for this purpose in Europe and America. But until fodder for stock becomes much more abundant than at present, the straw grown in Mysore will be required almost exclusively for feeding purposes. Many of the hill tops in the Malnad are, however, clothed with a dense mass of rank grass; and instead of burning this as is so frequently done at present, it might easily be collected by enterprising raiyats and used for litter. In places where these hills are steep it might be tied into bundles and rolled down the hills, as is frequently done in mountainous countries. Jungle soil if well dried, also forms a good absorbent. But of course, if wet, is practically valueless. In order to keep it dry it must of course be put under shelter on a

platform some distance say, six inches or a foot from the ground. Green leaves and twigs as employed at present to some extent in the Malnad are of course practically unless as an absorbent, though they doubtlessly help to add a little to the comfort of the cattle when housed in stables not cleaned out daily. Dry leaves serve however a very useful purpose as an absorbent, and further more like straw add some manurial constituents. In the appendix are given the analyses of several varieties of leaves gathered in Hassan District from the ground after dropping from the trees. These leaves must of course be kept dry just like all other bedding materials, if they are to serve the purpose of absorbents for the liquid manure.

With a better quality of manure, better care must also be taken of it. A manure containing little soluble plant-food can lose little by being leached with rain water, while that containing a very large proportion of soluble substance can of course lose much more. But in the better quality of manure containing considerable bedding or litter of an organic nature, especially if it is straw, there is much more danger in Mysore from a loss by excessive fermentation than from leaching. Apparently, the most rational system for preserving the urine is to apply absorbents in the form of dry litter in sufficient quantity to completely absorb the urine and keep the cattle comfortable and not clean out the stables until the manure can be applied directly to the field were needed and spread there. For, to leave the manure in loose heaps would cause a considerable loss of plant-food by excessive fermentation.

Fermentation is due to the presence of little plants called Bacteria living in the fermenting substance. Those which cause loss in manure by "over heating" require air to enable them grow vigorously. By keeping out this air from the manure we reduce the fermentation and the way to keep out the air is to either keep the manure wet so that the little spaces in the manure heap are filled with water instead of with air, or to keep the manure packed so tightly that very little air can penetrate it. By keeping the manure in the stables trampled tight by the stock, the air-spaces in it become very much reduced and the urine fills up a large portion of the remaining spaces so that fermentation is reduced to a minimum. If, however, the stables are cleaned out every day and enough litter is used to absorb the urine, the manure will be in loose heaps, air will easily enter, fermentation will go on rapidly and a considerable loss of nitrogen will occur. The looser these heaps, the more they are protected from rain, and the hotter the weather the greater this loss will be. There are, as will be observed, at least two sources of loss in manure, the one from excessive fermentation, the other from leaching. By protecting loose manure heaps from rain we reduce the loss from leaching, but probably greatly increase the loss from excessive fermentation. By keeping such heaps uncovered and permitting rain to soak into them we probably lose less. For although there will doubtlessly be some loss by leaching the loss by excessive fermentation will probably be reduced to an equal amount though very heavy showers would probably cause more harm than good. These questions require careful investigation in this climate if the manure is to be kept in loose heaps. But by keeping the manure well packed in the stables both these sources of loss are very materially reduced if not totally avoided. As has already been stated the cattle continually trampling on the manure compress it very much and reduce the air-spaces in the manure to a minimum. The system gives entire satisfaction in Germany and in those places in Canada in which it has been thoroughly tried. And as in Canada, during the summer months, the heat is occasionally for a few hours nearly equal to that of our average hot weather in Mysore, there is every reason to believe that the system will work well here if proper "bedding materials" are employed. And the intention of the Department is to make experiments with various absorbents which might be used for litter as soon as an opportunity offers itself to do so.

In the appendix are given the analyses of two samples of village cattle manure from Hassan District. The one No. 34 is comparatively fresh, the other No. 35 has been kept for some years in an exposed heap; neither of them contained any litter and in both but little of the urine has been preserved. Neither of them has probably suffered very much from over fermentation; as since they contained no litter little air can have penetrated the comparatively compact mass. Furthermore, the very large percentage of sand both these manures contain, will have had a tendency to retard rapid fermentation. The samples as received contained 61·23 per cent and 72·59 per cent of sand and gravel of which 27·5 per cent and 33·9 per cent of gravel respectively were sifted out of the manure before analysis. It would be interesting to know how much of this sand had passed really through the animal and how much has been admixed afterwards by digging out a portion of the floor of the stables when cleaning them out each day. There must however have been some considerable loss of weight in the older manure but taking for granted that the manures were of about uniform quality to begin with this loss of weight has in no way been compensated for by a better quality of the older manure. For, even after making due allowance for the larger percentage of sand in the older manure and taking account of the difference in moistfire the older manure is only $\frac{3}{4}$ of the value to the fresher product pound for pound. The maxim to apply the manure as fresh as possible to the fields where they are to be used, applies (so far as I can judge at present) with the same force in India as it does in America.

POONAC.—In the appendix are given the analyses of two poonacs, one, a white castor and the other hongey. Pound for pound this particular sample of white castor is twice as valuable as the sample of hongey, and barring the expense of application it is at least ten times as valuable as the better of the two samples of cattle manure referred to above, and owing to the fact that the nitrogen in the cattle manure is not likely to be in as available a form as in the poonac the latter is likely to be even more valuable than indicated above.

BONE-MEAL.—Two samples of bone meal were analysed. The results are found in the appendix No. 11 is much below the average in both nitrogen and phosphoric acid, and though sold as bone meal in India would not pass as such unchallenged in Europe or America. No. 12 is a good average untreated bone meal. Taking the latter to be worth say, Rs. 51 per ton and not making allowance for the difference in mechanical condition sample No. 11 would be worth only about Rs. 37 per ton. Bone meal, though a very favourite fertilizer with planters, has not received the attention from raiyats which I believe it deserves. On the Experimental Farms in Northern India it has, I am told, not given good results. But so far as my experience goes the plant-food which bone meal contains is deficient in Mysore soils, and bone meal is undoubtedly the cheapest form in which to apply this plant-food and considering the large percentage of iron in the soil, it is possibly the best form in which to apply it; especially if the soil is not deficient in organic matter. In Germany it is true the phosphoric acid in bone meal gave very bad results even on soils which required a phosphoric acid fertilizer. But in Japan where the conditions are more nearly like those in Mysore the results were very satisfactory and the indications are that in Mysore it will prove equally satisfactory, especially where the organic matter is not deficient. One of the reasons why bone meal has not been used to any large extent is doubtlessly that it is difficult to grind bones to powder and that when applied whole they are of little value. Of course the easiest way to prepare bones for use as a fertilizer is to disintegrate them by the use of the machinery made for the purpose. But this is comparatively expensive except when large quantities of bones have to be treated. To use sulphuric acid for the disintegration of bones after they have been broken to pieces by hand with hammers is much too expensive in India, where the acid cannot be bought cheaply; and further more it would require more skill and practice in the operation than the average raiyat possesses. Other ways have however been recommended, and the one likely to give good results in Mysore is to mix equal quantities of bones (broken to pieces by the use of hammers) with ashes in alternate layers and pour sufficient water over the heap to moisten it thoroughly without letting any of the water run away, and to keep it in a moist condition for several weeks or perhaps two months. The best results are likely to be obtained if the heap is nearly as high as it is wide or long, so as to have as little surface as possible. Of course a layer of ashes ought to be at the bottom and top and on all sides of the heap. This method is reported to have given very good results and is well worth a trial. Another method is to put the broken bits of bone in the manure heap. This gives good results when the manure heap contains the greater part of the urine, considerable quantity of litter and some horse manure. Whether it would be likely to give satisfactory results in the manure heap of the average Mysore raiyat is doubtful. Nevertheless it is worth trying too.

FISH MANURE.—Though this manure is used I believe to a considerable extent by the raiyats on the sea coast, it is only the planters and almost exclusively the European planters, who use this manure in Mysore. In the appendix will be found four analyses of fish manure in which the nitrogen varies from 3·96 per cent to 8·72 per cent and the phosphoric acid from 1·72 per cent to 6·12 per cent. If the richest of these manures could be bought for Rs. 52 per ton the poorest of these four samples would only be worth Rs. 22 per ton, or considerably less than half what the best of these four samples would be worth. What applies to fish manure and bone meal applies to a gerater or less extent to all manures and indicates that the quality of a manure must be considered as well as the quantity. Whether we are using the fertilizers produced on the land (such as cattle manure) or are using such manures as bone, poonac or fish, we should recognise that these manures may vary very much in themselves and always strive to procure the very best value we can get.

To determine the relative value of manures a large number of things have to be taken into consideration such as the "solubility" of the manure and its mechanical condition. It must also be remembered that phosphoric acid cannot take the place of nitrogen or potash or *vice-versa*. That each plant-food has its own work to perform which cannot as a rule be done by any other kind of plant-food. Making allowance for all these things we may say that nitrogen is generally about three and a half times as expensive as either phosphoric acid or potash.

Together with the analytical results of the samples of fish will be found that of a sample of prawn manure, which resembles fish in many respects.

SUGARS.—In the appendix will be found the composition of 15 samples of juice from sugar-cane, four samples of juice from sugar-beets and 12 samples of jaggory. Samples No. 167 to No. 195 inclusive were from Sulekere. The object of the work was primarily to see how the Sulekere sugar-cane compared with that of other parts of the Province, with a view to encourage if possible the establishment of a modern Sugar-house under that large tank where thousands of acres of land, all in one block, could be devoted to sugar-cane growing. Unfortunately owing to lack of labour in the harvesting season the crop of cane growing there was overripe. Very few seed heads were present however, and only here and there had the cane begun to sprout at the joints. The cane was not at all vigorous and in places dead and stunted canes could be easily picked out. The latter was possibly due to the excess of alkali in the soil, which, I fear, was present to a greater or less extent in a larger portion of the lands under the tank. In some places the "alkali" or "choulu" was present to such an extent that absolutely nothing appeared to grow on them, and in many places the quantity present had apparently affected the growth of the cane to a considerable extent, as indicated by a poor growth and many stunted and dead stalks on these spots. Of course lack of manure may have had something to do with this in certain fields. But undoubtedly the "alkali" was an important factor.

When comparing the percentage of sugar (sucrose) found in the cane grown in this locality with that grown in other parts of the State (*vide* the second Annual Report of this Department) it will be found to be very low. This is likely due (to a large extent at least) to the "alkali" or "choulu" in the soil. As will be noted the average of the 14 samples of Sulekere cane juice was only a trifle over 15½% of sucrose and the highest percentage was only 16·3 of sugar, while last year out of the 33 samples of cane juice taken at various places throughout the Province only three dropped down to this maximum of Sulekere cane juice, and one of these was a decidedly immature sample. The average of these 33 samples was fully 2½% higher than that at Sulekere (being a little over 18% and the maximum was nearly 5½% higher than at Sulekere, *viz.*, 21·6%. The glucose of the Sulekere cane is on the other hand quite double that found in cane grown in other parts of the State. The coefficient of purity is necessarily much lower, and above all the percentage of soluble ash in the jaggeries is very high indeed. Unfortunately I have no figures as yet for soluble ash in jaggeries of other parts of the State for comparison. The soluble ash retards the crystallisation of sugars even more than the presence of glucose, and for sugar production a juice containing a high percentage of soluble ash is avoided even more than one containing a high percentage of glucose. In fact No. 188 and No. 195 contained so much soluble ash that in conjunction with the very high percentage of glucose they contained, it prevented the sugar completely from crystallising. All attempts to make of them anything but a soft, gummy, somewhat elastic mass were fruitless. Under these circumstances Sulekere could not be recommended as a suitable site for a *pioneer* sugar factory. In the sample No. 195 referred to above the glucose is frightfully high, and fully 10% of it has been formed during boiling, and this notwithstanding that sufficient lime had been added to the juice before the boiling began. Judging from the results obtained last year not more than half this amount can, I believe, be normally attributed to over-heating. To what other factor or factors the remainder of the inversion is due I am unable to say at present. Fortunately nothing of the kind was noticed in other parts of the State. Sample No. 188 which was taken from the same field as sample 195 showed the same peculiarity but not quite to the same extent. In it the soluble ash and the soluble carbonates were even higher than in No. 195, and there is some doubt as to its having been limed to neutrality. In all the samples a considerable amount of inversion has taken place during boiling, and in No. 189 to No. 195 inclusive this cannot be due to improper liming.

Having spoken about "alkali" or "choulu" lands under this heading, I may mention that, following my recommendation, a particularly bad piece of such land at Sulekere was thoroughly drained and has very materially improved since. None of the white incrustation has appeared on the surface this year, and as time goes on the improvement is likely to continue. In the same digression I may also state that as a general rule sugar-cane is treated too much like paddy in the matter of irrigation, and that according to the experience in other countries sugar-cane resents such treatment. Our quality of sugar-cane is as a rule, very good, but we have to learn a lot about both its cultivation and manufacture. What can be done is illustrated by a plantation on the Hawaiin Islands. One of its fields about 100 acres in extent produced on the average a little over *ten tons of sugar per acre.*

In the appendix are also given several analyses of sugar beets at various periods of their growth. They were planted by Mr. G. L. Chambers in his compound at Bangalore on August 15th of last year. The analysis made on March 21st of this year after the beets had been growing 7½ months is similar to that of beets in other countries. But notwithstanding this the sugar beet can never be seriously thought of as a sugar producing plant in Mysore, where sugar-cane offers so vastly superior advantages to the beet; at any rate no such thought need be entertained until the manufacturing processes of sugar-making in Mysore have been placed on a totally different basis than they occupy at present.

INSECT PESTS.

Entomology and Chemistry are so far removed from each other that one man cannot possibly take up both these subjects if he hopes to do good work in either one or the other. The attention given to entomology has therefore been very small indeed. But as there is no one at present in a better position to take up this very important branch of agricultural science it was necessary to give it some time and to deal with the questions as well as the circumstances would permit.

The applications for advice and assistance in fighting insects have been numerous. But as heretofore the attacks have generally been brought to the notice of this Department much too late. Sometimes months have been allowed to pass in which the insect pests wrought their havoc and grew to their full size.

Naturally as these insect pets grew and approached maturity their appetite became greater and the damage they did each day increased also. As mentioned in my bulletin No. 1 when the larvæ, which generally do the damage to the crop, are full grown they crawl away to some protected spot to pupate. It was generally just before the pests reached this stage that the damage was reported and they disappeared on their own accord before any remedy could be applied. Unfortunately the insects did not die as is generally believed by the raiyats but they simply passed into another stage of life ready to appear again in full force next season, or possibly two or three seasons later. The idea that the pest is killed by the rains is a very comforting but a *very* mistaken one.

CASTOR PEST.—Last year a report was received that caterpillars were causing great damage to Caster oil plants in Davangere. Immediately instructions were sent to apply Paris Green.

In reply to this it was reported that the good rains which had since fallen had killed all the caterpillars and that none could be found to send as samples. This year exactly the same information was received from Davangere through another source with exactly the same results. The attack of the carterpillars was reported too late to apply the Paris Green. The caterpillars had all been "killed" by the late rains before the Paris Green could be applied. The progeny of these caterpillars which were supposed to have been "killed" by the late rains, (because none were seen afterwards either dead or alive) will most likely be ready to partially destroy the next crop of castor in that district exactly the same as has been done in the past. Insects multiply very fast and if it were not that they have a large number of enemies which destroy a large number of them (often in the pupa or resting stage) they would spread so rapidly that any form of agriculture would be practically impossible. But as I mentioned in the bulletin referred to above if we assist nature to produce an extra amount of crop for our benefit we should also assist nature to protect these crops from the attacks of insects. We should try to harvest the crops and not permit insect pests to do so if we can avoid it, and though it is difficult to stamp out entirely any one of these insect pests it is well within our power to materially reduce these attacks and one of the best means of doing so is to use Paris Green against all leaf eating insects as recommended in the special bulletin on this subject.

DATE PALM PESTS.—(*Rhynchophorus ferriugineus & Oryctes rhinoceros.*)—Shortly before retiring from the Mysore service Mr. A. S. Kearns sent me specimens of two beetles which attacked date trees on the reserves of the Mysore Abkari Department. The one was a brown beetle of medium size with darker spots and a very long snout so characteristic of this class of beetles that they are commonly known as snout beetles. The other was a somewhat larger dark brown beetle with a peculiar hump on the back. The former belongs to a family famous for the large number of injurious insects it contains. The latter is closely related to the well known "Tumbling bug." In its larval stage the former burrows in the 'tops' of the date palm ultimately killing it if present in sufficient numbers and always injuring it. The only remedy I can suggest is that already mentioned by Mr. Kearns *viz.* to burn the trees. Major, Alcot, I. M. S., Superintendent, Indian Museum, Calcutta, who kindly indentified these beetles says :—"The beetles you forwarded with your letter No. 195 are the well known palm pests. The snout beetle is Rhynchophorus ferrugineus, Olio. The other is Oroctes rhinoceros, Linn. The only remedy that I can suggest is to cut down and burn all trees which you know to be infected by the larvæ." For the opinion expressed by some that the larvæ are bred in cattle manure there is, I believe, no foundation and the remedy suggested by them to exclude cattle from date reserves is, so far as I can see, not likely to affect the question one way or the other.

COFFEE PEST.—*Green bug (Lecanium viride.)*—At the beginning of this year (1901-02) some letters appeared in the *Madras Mail* and *Planting Opinion* about an insect pest affecting very extensively the figs used as shade for coffee; and spreading from them to coffee and weeds growing in the neighbourhood. The letters were sent from Santaveri, the choicest coffee growing district in the State. On visiting the affected district I found that although the pest had been known to occur on a solitary tree in the maidan country not far from the Babaduden hills it had not been noticed in the coffee of that district before, but had suddenly appeared that year and spread with alarming rapidity. Many of the figs (ficus glomerata) were literally covered with it and some of the branches of these trees had already died back. In the affected area hardly a tree could be found which was free from it. The coffee too was badly affected. Before visiting the affected area I recommended the application of kerosine emulsion. But when realizing the large area which would have to be treated and the height of the affected trees it was evident that such a course would be almost impossible and certainly prohibitive so far as the cost was concerned.

Possibly some practical remedy may suggest itself when it is possible to study the reasons for this sudden increase of the pest in a district in which it had existed to a very limited extent for years. But this can of course only be done by a man who has had special training in the subject and can devote practically all his time to this and similar questions.

A sample was sent to the late Mr. Lionel de Niceville, Entomologist to the Government of India. He was also asked to suggest such remedies as he thought might be efficacious in fighting this pest. As I expected the pest to be the ill famed "Green bug" and as a considerable sum of money had been spent in the attempt to import lady birds from Australia in the hope that among these might be some which would feed upon this green bug and as in my opinion such an experiment had little chance of success I asked Mr. de Niceville to express his opinion on this point. The following is his reply :—

"In reply to your letter No. 58 of 23rd instant, the scale insects which you have sent me as affecting coffee and its shade tree, are *Lecanium viride*, Green. This scale insect has been known for many years past as a severe pest of coffee. The "mealy bug" appearance of the specimens sent is caused by a white mould, and is not secreted by the insect itself and appears to show itself most in very wet weather."

"As for remedies, I fear that kerosine emulsion is practically the only means of combating this pest, and will be found the cheapest. As for the likelihood of the South Indian Planters eradicating this pest by the importation of lady birds, I am not in a position, not having any

data to go by, to give an opinion on the subject. I fancy, however, that it is useless to go to Australia for lady birds, as it is very unlikely, except in the case of some cosmopolitan species that they will eat the green bug. What is required is to endeavour to find out the original home of this pest, and import the lady birds which feed upon it there, taking care not to import their parasites as well. The success of *Vedalia cardinalis* in destroying *Icerya purchasi* was due to the original home of both being Australia, from whence the latter was imported into California. Mr. Koeble therefore naturally turned to Australia for a parasite of *Icerya purchasi*. Owing to this experiment being successful, it does not follow, that we should, without some good reason, go to Australia for lady birds as a cure for scale insects which may hail from quite another quarter of the globe.

"*L. viride* is subject to the attacks of several species of lady birds, parasitic *Hymenoptera*, Sachinid flies, lace-wing flies, etc., in Ceylon. As they however are themselves kept in check by their own parasites, they have not proved, as far as I know, to be of any very great use Without a personal examination on the spot however, it is difficult to indulge in anything more than surmises."

Ragi Pest.—Several reports have been received of insects attacking the roots of various crops. But as I have not received samples and as the attack had disappeared when I visited Kadoor in which an attack was reported at the time, I am unable to say anything further about the subject than that if insects really attack the roots of ragi and other crops as reported it will be a difficult matter to find effective remedies.

Coffee Pest. Mealy bug, (Dactyliopus —?).—The only root insect I have actually seen is a mealy bug affecting coffee in Coorg. The same mealy bug also affects the roots of shade trees and those of some weeds in that State. But its attack is still confined to comparatively limited areas and although some planters suffering from it consider it to be the worst of all the ills they have to contend with their neighbours who have escaped thus far make very light of it. It is reported to have been introduced in manure from Mysore territory where it is said to affect ragi crops. But it will be difficult to prove that such is really the case even if it should be found to infest ragi in this State. The insect resembles in general appearance the well known "mealy bug," is about one-eighth of an inch in length and affects, as stated above, principally the roots of coffee. Occasionally it is seen however on the stem as well. It prefers the young plants to the older ones, and is particularly bad in nurseries and newly transplanted coffee. A specimen taken from some weeds growing in coffee was sent to the late Mr. de Niceville for identification. His reply was as follows:—

"In reply to your letter of the 27th ultimo, I beg to report that on examination of the roots of weeds growing in the coffee plantations in Coorg you sent me, which you say are attacked by "mealy bugs" which do great damage to coffee, I found only two or three half-grown females which appear to be species of *Dactyliopus*, and that the material sent is insufficient for closer identification, adult females being required. It is useless, and hopeless to suggest any remedy for the pest without some knowledge of its life history of which I am entirely ignorant. As, however, I trust to be able to visit Southern India shortly I shall then be able to make investigations regarding this and other pests affecting coffee on the spot."

Paddy Pest (Cecidomia oryzæ).—The insect attack to which I have been able to devote, most attention during the year was one occurring in Mysore District (T. Narsipur Taluk) on paddy. It was reported to have almost totally destroyed the paddy on several square miles of country in a locality where paddy field joins paddy field as far as the eye can reach. In reality the attack was not nearly so bad as reported for although there was a fairly general attack for miles along the main road and although the paddy was totally destroyed in places, yet there was nothing like a total destruction of the paddy over the area visited, and the same thing will probably hold good for the portion of the affected area lying inland. Still the attack was a very severe one and the aggregate loss to the raiyats must have been enormous.

The most noticeable feature of the affected paddy was that the stalk had no ear-heads. The stalks were much below the normal height and terminated either abruptly, as though cut off, or were capped by a short withered pointed portion which was the undeveloped part of the stem with the embrio ear-head cut off by the insect before the paddy had begun to "shoot." At the top of the abnormally developed remnant of the stalk it was abnormally closed. This closing so mewhat resembled a node but had really nothing to do with these normal partitions in the stem. The stem had no nodes or joints. As might be expected the affected plants tillered, or stooled, extensively in their attempt to replace the affected stalks but generally these had also fallen a victim to the pest. Apparently the later sown paddy had suffered most. So far as I had an opportunity of observing it the fields which had been neglected most in the matter of cultivation and manure were also those which suffered most from the insect pest. It was, so far as I could learn, the first attack of its kind in that locality, though doubtlessly the insect must have existed there to some extent before, to cause such a wide-spread attack—seven miles in extent—this year. Without making a much more careful investigation of the subject than I have been able to make it is impossible to say what was the cause of this sudden spread of the insect pest. Many reasons might be suggested however. I shall mention two of these later on.

The larvæ of the insect, yellowish white maggoty-like creatures, burrow in the stem of the paddy before the internodes have begun to develop, or in other words, before the paddy

has begun to "shoot." They are generally found quite close to the crown, the division line between roots and stem. Generally but one maggot is found in the affected stem, though rarely two or even three of them are found in the same stem. They confine their attention to the central portion of the stalk leaving the outside in tact. Though hundreds of affected stems were examined but two pupae were found. One was evidently destroyed when slitting the stem open, the other was simply the covering from which the mature insect had already escaped. This fact suggested to me that possibly the insect normally pupates outside of the affected stems. The larvae when apparently full grown measured about 3/16th to 1/4th of an inch in length. It was never found in stalks which had made an attempt to "shoot." In a very large number of these nothing at all could be found. The older ones were quite open at the top and had died back to the crown. The younger ones were still green and generally closed at the top, but just below this a hole had been eaten into the side, of the stalk from which insects had evidently escaped. In about seventy-five per cent of the youngest and freshest of these green stalks were found a cluster of from 10 to 30 tiny little egg-like bodies (probably pupae) grouped together in an oval shape and though I was unable to find a membrane covering this cluster of egg-like bodies I expect they were the pupae of a parasite, feeding in the maggots which affected the paddy and of course killing them. These little egg-like bodies when hatched produced tiny little black flies probably one of the *Proctotrupids*. In a few stalks which had not the little opening eaten into it near the top I found some of these tiny black flies; in some of the stems they were dead while in others they were still alive. The only reference I have been able to find of a similar attack is that given, in the Indian Museum Notes of an attack in Behar in 1880 described by Mr. Woodmason. He named the pest provisionally "*Cecidomia Cryzae*" but apparently very little is known about it. A sample was sent to Mr. Lionel de Niceville. He received the sample when ill a few days before being taken to the hospital in which he died about a week later. I owe him a deep debt of gratitude for all the services he has rendered me in the short time he has been permitted to occupy the position of Entomologist to the Government of India, and cannot deplore too deeply the loss occasioned by his death.

One of the reasons which may be suggested for the sudden appearance of this paddy pest is that last year the water-supply in that locality was very low, as a result the paddy was not irrigated nearly as much as is generally considered necessary and possibly the insect pest may have had a better opportunity to find safe places in which to pupate. Another reason which might possibly be advanced is that for some reason or other there may have been an epidemic in the parasites mentioned above and that as a result a comparatively large number of insects escaped destruction the previous year and were ready to lay eggs from which the maggots hatched this year. Should this pest re-occur it certainly ought to be carefully studied by a specialist so as to find means of overcoming the attack. The only remedies I might suggest are to sow the paddy as early as possible and cultivate it and manure it as well as circumstances will permit. Similar remedies have been found effective with the Hessian fly, an insect which apparently resembles this one in some respects.

MANGO PEST.—(*Euroctis lunata*).—In May of this year, information was received that an army of insects was attacking mango orchards in the north-eastern part of Tumkur District. They originally confined their attacks to various members of the Accasia family, but after defoliating a large number of these attacked the mango orchards in force, destroying practically all the fruit and a large portion of the leaves and young shoots as they went from tree to tree. According to the report of the Amildár of Maddagiri about 30 to 50 square miles were infected with this pest. Last year, though I have heard nothing of it at the time, the attack appears to have been even worse than this year. The only effective remedy I could recommend was to spray the trees with Paris Green. To do this easily and effectively a specially constructed force pump is necessary, and this I was unable to secure in Madras, and having none myself the only way to apply the Paris Green was to climb the trees and sprinkle it on with an old broom, a very difficult, dangerous and imperfect way. Samples were sent to Mr. Green, Entomologist to the Government of Ceylon, for identification. In reply he wrote:—"The caterpillars are the larvae of *Euroctis lunata*. I doubt if anything but some arsenical preparation sprayed upon the foliage would kill the caterpillars. But the pest might be partially checked by jarring the branches and crushing the fallen caterpillars. When the moths begin to emerge, large numbers of them could probably be destroyed by the use of lamps set in basins containing water with a film of kerosine. Messrs. Vermosel & Co. have constructed a very useful acetylene lamp for this purpose, at a cost of 16 francs (at Marsailles) complete with basin etc."

Conclusion.—An opinion prevails among many that in India agriculturists suffer but little from insect pests. Nothing can be further from the mark than this.

The pests I have mentioned above are only a part of those I have happened to meet during the year, and these are naturally but a small portion of those which actually exist. For example, in certain parts the boll worm practically prohibits cotton growing of any sort. Still if an attempt were made to calculate the damage done by the pests mentioned above these in themselves would make an enormous total. In the interests of Agriculture I should heartily welcome an Entomologist to these parts of India in which the services of such a scientist are urgently needed.

AGRICULTURAL EXPERIMENTS.

After three years of observation of the chief requirements of the native agriculturists of Mysore, I still hold the opinion that the most essential of these is a better food supply for their stock, especially during the hot weather. There are large areas of waste lands and village grazing lands on which the raiyats largely depend for fodder for their stock. In very few instances does any native agriculturist provide pasturage on his own fields. As a rule he prefers to let his cattle subsist on the free pasturage to which he is entitled rather than provide pasturage for them on lands on which he has to pay taxes. In addition to the free subsistence allowance for his stock, he hopes to carry away a little manure from these common pasturage grounds with which to enrich his own fields. That under these conditions the pasturage is of the very poorest kind is only natural. The grasses are rough and coarse and as a rule cover the ground but imperfectly, and on the poorer lands shrubs and thorns occasionally occupy a large portion of the space. Occasionally, even on good lands where the original surface has probably been washed away by rain the surface now exposed is so hard and baked that nothing can grow on it at all. In some instances these free pasture lands produce, if not grazed, a crop of grass which might be cut for hay. In fact many of the hill tops in the Malnad produce a dense growth of coarse rank grass. But on the average grazing lands the grass is very sparse and the growth slow.

Accustomed to the marvellous change generally produced in America by ploughing up old run down pastures, breaking up the hard and matted surface, converting the tangled mass of wild grass roots to manure and replacing the poor wild varieties of grass by those which have proven themselves much superior, it was natural to suppose that somewhat similar results could be produced here by a like method.

A piece of very fine looking waste land near the laboratory was ploughed up, carefully cultivated, divided into plots 1/200 of an acre in size and seeded down with the following varieties of grasses and clovers:—

	Elymus Canadensis	
	Bromus Schraederi	
	Bromus inermis from	U.S.A.
	Do	England
Orchard grass	*Dactylis glomerata*	
Tall oat grass	*Avena elatior*	
Timothy	*Phleum pratense*	
	Bouteloua oligastachya	
Italian rye grass	*Lolium Italicum*	
	Lycurus Phleoides	
	Paspalum dilatatum	
Bermuda grass	*Cynodon Dactylon* from	U.S.A.
Hariali grass	*Cynodon Dactylon*	Native
Giant hybrid cow clover	*Trifolium Pratense*	
Sutton's perennial red clover	*ditto*	
Provence Lucerne	*Medicago sativa*	
American do	*ditto*	
Indian do	*ditto*	
Turkestan do	*ditto*	
Giant Sainfoin	*Onobrychis sativa*	
Japon clover	*Lespedeza striata*	
Bokhara	*ditto*	

Many of the above seeds were kindly sent me by the Department of Agriculture at Washington U.S.A. They were specially selected for Mysore where drought resisting tendencies are of special value. Of the remaining seeds most were imported from England. Duplicates and triplicates of many of these plots were made to test different methods of sowing and cultivation. Hariali for example was sown by seed on one plot, on three others it was re-produced by cuttings. On one of these plots it was laid in the furrows and completely covered by the succeeding furrow. On another plot it was treated in a similar way but a part of the stem remained above ground. On a third plot the hariali grass was cut into lengths of about 2 to 4 inches was sown broadcast and sand sprinkled over it to keep it in place. All the plots grew finally about equally well, though that sown broadcast on the surface made the easiest start and stood evenest to begin with, next came the plot in which the hariali had been ploughed in but not completely covered, while the plot in which it had been completely covered was the last to show an even stand. The seed did not germinate at all.

In Lucerne there are several varieties which are not well known nor well recognized. The Lucerne as grown in India is an irrigation crop, while in California, Lucerne or Alfalfa as it is called there, is known for its drought resisting tendencies. In America it is often sown on light sandy soils and on such soil the roots have been traced to a depth of ten feet and more. As the object of the experiment was to see what could be done with these varieties of grasses and clovers on the ordinary waste lands by good cultivation without manures, of course no manures were applied to these or any of the other plots. The soil was too poor to produce any satisfactory growth on any of the Lucerne plots though irrigated and therefore not suffering for want of water. What little difference there was in growth was in favour of the acclimatized seed. The plot on which the acclimatized clovers was sown the clover was cut four times and produced a little over 51 lbs. on 1/200 part of an acre. The other plots of Lucerne of the same size were cut only once at the close of the experiment and produced from 7 lbs. to 10 lbs. each. The soil was very much inclined to form a crust and cake throughout. The poor growth was at first attributed to this peculiarity of the soil. Several duplicate plots were sown, some were dug, some mulched and some limed to overcome this caking tendency. But the poverty of the soil debarred any of these treatments taking any effect. On all the plots the growth was practically at a stand-still when the plants were from 4 to 8 inches high.

The results obtained with most of the other clovers and grasses were even less satisfactory than those described for Lucerne and corroborated the conclusion which may be drawn from the results with that clover, *viz.*, that if the waste lands experimented on represent the bulk of the waste lands throughout the State, cultivation alone will accomplish but little in the way of improving the food supply for stock. That even the introduction of good varieties of grasses will be of little use unless the lands are manured in some way or other. Whether the waste land experimented on is a true representative of its class requires to be investigated by repeating the experiments in other parts. From its appearance it would rank rather above than below the average. But I sincerely hope that in this case appearance will prove to be deceptive.

In addition to the poverty of the soil all sorts of diseases and insect pests had to be contended with. There was hardly a plot which did not become diseased more or less sooner or later. This was particularly true of the grasses. Several of the plots were completely wiped out shortly after they had stopped growing and at the close of the year but few individual specimens of the imported grasses were alive. No doubt the poor soil was largely to blame for these attacks. Attempts were made to identify some of the diseases, but as they were out of the ordinary course of the well known plant diseases it would have taken a specialist years to investigate them.

The best results among the grasses were undoubtedly obtained from hariali. It completely covered the soil and made some growth as well so that at the end of the year a small amount of crop, 5 lbs. or 1,000 lbs. per acre was realized. It too appeared to be affected with a disease, which resembled somewhat in external appearance "rust" on wheat and oats. But when examined microscopically it was found to be totally different. Quite a number of spores were found but they belonged to different families and were evidently not the cause of the disease. Dr. Butler, Cryptogamic Botanist to the Government of India, afterwards identified the supposed disease to be due to the puncture of a tiny gall insect, which had caused botanists a great deal of trouble until investigated by Professor Magnus of Berlin.

The experiments indicate that hariali grass is much easier to grow than is generally believed in India, and will exist on a soil on which many of the other good variety of grasses will perish. If sown during, or just before, the monsoon, it is certainly not necessary in Mysore to go to the great expense of dibbling in the grass, a practice very largely, if not universally, adopted at present. It is not even necessary to mix the cut grass with cattle manure and other substances as sometimes recommended. In fact it is doubtful if that method will answer as well as that in which the cut grass is simply held in position by a little sand. A top dressing of manure is however highly desirable. Experiments will however have to prove whether it is better to apply this at once or to wait until the grass has taken root.

Several other crops were experimented with on these plots near the laboratory. Among these were horse gram, cow gram, ragi, cholum, ganja vetches, blue lupines and potatoes.

In none of these was any sort of manure used. The vetches germinated well, but apparently did not grow much beyond the stage to which the reserve materials in the seeds sown permitted them to grow. The lupines however grew to a height of about 18 inches, but had a sickly appearance all the time. The lower leaves dying as those on top were being formed. The crop when cut weighed a trifle less than 20 lbs. The plot like all the others mentioned before was 1/200 of an acre.

The ganja grew about the same as the lupines. It had a sickly appearance. The stand was very uneven. The male plants were removed as is usually done and about 11 oz. of the pressed cake was obtained. The plot was however nearly 1/100 of an acre.

The potato plot was 8 times the size of the ordinary plots. To keep off the potato disease it was treated frequently with Bordeaux mixture. Like all the other plots it was regularly cultivated and did not suffer for want of water. Still the yield of potatoes was less than the seed which had been sown.

The stand of all the remaining crops was also very poor, but decidedly better than the poor stand of grass and other crops mentioned above might have led one to believe. The Bengal gram gave a crop of 10 oz. and nearly 1½ lbs. of straw. The total weight of horse gram and straw harvested was 29½ lbs. The ragi had been eaten by birds. The total weight of straw and the little grain left was 9 lbs. The cow gram grew fairly well on a part of the plot. It was cut green and weighed 57 lbs. The cholum had been injured several times by stray cattle, donkeys etc. The crop of stalks and such ear-heads as were left weighed 32½ lbs. when cut. All the plots were 1/200 of an acre.

The experiments as a whole appear to indicate that the crops usually grown by the raiyats can subsist on very poor land more easily than the grasses and clovers and potatoes tried on the plots this year. They further illustrate that there is something radically wrong with the soil. Possibly it is too poor in composition to produce anything like a medium crop, or possibly the fact that it has been exposed to the tropical sun for years without a crop to protect it, has in some way or other affected its productiveness. But to return to the original object of the experiment, that of the better pasturage for stock, it is very doubtfull, as already stated, if cultivation alone will enable the raiyats to supply better pasturage for their stock. It most likely requires the assistance of manures. But as has been pointed out in a previous section of this report, there is every prospect of the raiyat being able to materially increase his supply of manure with a little extra care and energy.

SHADE FOR COFFEE.

At the request of some of the leading South Mysore Planters, twelve samples of leaves from some of the best shade trees have been analysed. The leaves were collected and named by Graham Anderson, Esq. C.I.E.; and there could be no better guarantee of the samples being true to name. The analyses are not quite complete at present, the potash in several samples not having been determined. Furthermore there ought to be a few samples of leaves from proverbially bad shade for comparison before the results can be intelligently discussed I therefore simply give the analytical results at present, with the one comment that many of the leaves contain a higher percentage of nitrogen than might be expected, considering they are those which have dropped from the trees in the natural course of events, when a large portion of the nitrogen is doubtlessly re-absorbed by the tree in the protoplasm which travels back to the stem before the leaves drop.

EXPERIMENTS WITH FERTILIZERS ON COFFEE.

Twelve plots of coffee were selected on as many different estates for experiments with fertilizers. These experiments have the double object of telling the planter of what kind of plant-food his estate is in greatest need, and of giving some indication as to the kind of plant-food most required by coffee. For, as is well known, some plants require more of one kind of plant-food to be given them, while for other crops it may be advisable to let another kind of plant-food predominate. For example, for most grains, other things being equal, nitrogenous fertilizers respond best, while legumes generally require potash and phosphoric acid most. What coffee requires most on an average soil is quite unknown. The experiments are therefore primarily to test the soil of the estate on which they are carried on and as such are only applicable to the estate on which they are carried on. But the secondary object of finding out some general principles as to the manuring of coffee is of course of general interest and a very important one. In order to be able to get any information on this latter subject it is necessary to know as thoroughly as possible the composition of the soil on which the experiments were made. As was reported last year, great care was bestowed on the taking of these samples. Two were taken from each plot, one representing the top foot, another the second foot of soil. Each sample was made up of 10 to 25 different borings taken at regular intervals. Unfortunately several of the planters who had undertaken these experiments discovered afterwards that they were unable to carry them out; and owing to the almost total failure of the coffee crop, those experiments which were carried out are this year practically valueless. For, since the cause of the failure of the crop cannot be attributed to the lack of fertility in the soil, the application of fertilizers to the soil can have had very little, if any, effect on the very small crop picked this year. The results of the experiments this year would be misleading if any difference in crop, is attributed to the fertilizers applied. They are therefore not given, and as the analyses of the samples of soils taken from these plots are principally of no value when studying these experiments they are also omitted; notwithstanding that about half of the work connected with these analyses has been done.

CORRESPONDENCE.

The total letters received were 762 and those sent 751. Of course, no account would be taken of this part of the work if the correspondence were all of the ordinary office nature. But though a large number of letters are of course connected with ordinary office routine, a large number were answers to questions relating to some one or other branch of agricultural science. The time involved in obtaining the desired information and in answering these letters was by no means insignificant, and of course the work connected therewith had to be done almost entirely by the Agricultural Chemist. Frequently the entire day had to be

spent in this work. But though this information is given to individuals and generally relates to some special problem, it is nevertheless cheerfully given; and as it has the great advantage over general information, that it is likely to be acted upon by the persons who receive it; and as such correspondence has a number of advantages which need not be enumerated here, it is a branch of the work which is considered eminently useful and important. The subject which has been apparently of greatest interest to correspondents has been insect pests and plant diseases. 93 letters were received and sent under this heading. Next comes Chemical Analyses with 92. Next in order are coffee experiments, sugar industry, general agricultural experiments, and fibre industry. Instead of writing for the information they desired, quite a number visited the laboratory and asked for the information they wanted. Of course no account is kept of such inquiries. Among the visitors were several deputations or what appeared to be deputations.

MACHINES AND IMPLEMENTS.

Many of these visitors asked questions relating to the use and probable expense of various farm implements and machines, principally, ploughs cultivators and drills and rice-hulling machines. Generally the very smallest and lightest implement which will do the work reasonably effective is desired, though once information about a steam plough was desired. This was, needless to say, quite unsuited for the existing requirements (small paddy fields). Several inquiries have also been made about sugar machinery and implements. Several visitors desired to know all about the machinery necessary for a modern sugar house on a small scale. But the capital necessary for such an investment was invariably much more than they had at their disposal. I sincerely hope that shortly I shall be able to have a permanent exhibit of such improved implements and machines as, after being tested, appear to be suited to the requirements of the raiyats and other agriculturists.

Reports, etc.—One report and two bulletins have been printed and sent free of charge to residents of the State who applied for them. One thousand English copies and 5,000 copies of the Kanarese translation have been printed in each case, and of these all but a few hundred copies have been distributed.

A. LEHMANN,
Agricultural Chemist.

Juice of Sugar-cane from Sulikere and Jaggories boiled from it.

Number.	Substance.	Moisture, per cent.	Glucose.		Total solids, per cent.	Soluble ash, per cent.	Soluble carbonates, per cent.	Sucrose, per cent.	Loss of reducible sugar by inversion calculated, per cent.
			Total per cent.	Formed by inversion calculated per cent.					
167	Juice	...	·97	...	17·9	...	...	16.3	..
182	Jaggory	6.13	6·67	1·9	...	2.74	.75	79.7	5.7
168	Juice	...	·98	...	15·6	...	...	14.2	...
183	Jaggory	4·50	1·11	5·9	...	3·56	1.04	74.1	17.7
169	Juice	...	·92	...	17·6	...	...	16.2	...
184	Jaggory	2·95	10·6	6·2	...	2·63	1.02	76.8	18.6
170	Juice	...	·90	...	17·1	...	...	15.8	...
171	Juice	...	·91	...	17·6	...	...	16.2	...
186	Jaggory	3·55	8·70	4·3	...	3·24	1.02	78.4	12.9
172	Juice	...	·72	...	17·7	...	...	16.3	...
187	Jaggory	5·45	13·9	10·9	...	2·99	.96	76.7	32.7
173	Juice	...	·96	...	17·5	...	...	16.0	...
188	Jaggory	9·45	13·5	9·9	...	3·80	1.37	59.2	29.7
175	Juice	...	1·19	...	16·6	...	...	14.3	...
189	Jaggory	4·80	6·25	4·5	...	3·02	1.27	80.1	13.5
176	Juice	...	1·16	...	16·1	...	...	14.9	...
190	Jaggory	6·25	11·10	5·2	...	3·42	.96	75.7	15.6
177	Juice	...	1·10	...	17·6	...	...	15.7	...
178	Juice	...	1·02	...	17·5	...	...	15.8	...
179	Juice	...	1·00	...	17·4	...	...	16.1	...
193	Jaggory	3·82	10·6	5·9	...	3·20	.93	75.0	17.7
180	Juice	...	·76	...	17·2	...	...	14.8	...
194	Jaggory	5·42	12·50	9·2	...	2·95	.95	65.6	27.6
181	Juice	...	1·04	...	17·2	...	...	15.8	...
195	Jaggory	9·57	15·6	11·0		3·33	1.20	70.0	33.0

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Juice from Sugar Beets (Austrian) Sown August 15th 1901.

Number	Age of beets in days	Weight of leaves in grammes	Weight of beets in grammes	Total solids	Sucrose	Coefficient of purity	Remarks
...	...	...	...	...	3·7	...	
164	94	642	344	9·9	7·6	77	
164 (*a*)	118	304	478	10·4	7·0	67	
165	228	146	496	18·3	14·7	80	

Juice from Sugar Cane and Jaggory from Saklespur.

Number	Substance	Glucose	Total solids	Sucrose	Remarks
196	Juice	5·55	22·6	16·7	The cane had been cut 15 days before it reached laboratory and looked shrivelled up.
197	Jaggroy	11·8	...	78·2	

Analyses of Ripe Leaves from Hassan District collected after they had fallen.

No	Local name of Tree	Botanical name of Tree	Nitrogen %	Phosphoric acid %	Insoluble Residues %	Iron and Aluminium Oxides %	Lime %	Moisture, Organic and Volatile matters (approximate) %	Remarks
36	Gönee	Ficus Mysoriensis	0.821	0.155	4·62	1·08	5·29	96	The names of the trees are given in the order of merit for shade for coffee as selected by a Committee of Planters in Saklespur. The leaves were collected and named by Graham Anderson, Esq., C. I. E., of Barguai estate.
37	Kare Busree ...	Ficus infectoria ...	0·932	0·157	6·46	0·87	5·11	82	
38	Cub-Busree	Ficus ...	0·811	0·151	6·76	0·38	3·01	87	
39	Attee	Ficus glomerata ...	0·915	0·163	8·38	0·71	5·57	78	
40	Beete	Dalbergia latifolia ...	1·597	0·225	1·64	0.99	1·77	93	
41	Jack	Atrocarpus integrifolia ...	1·067	0·112	8·67	0·65	2·77	85	
42	Mullay Gerguttee	Ficus ...	0·838	0·115	12·54	0·76	5·45	76	
43	Wartee		1·07	0·137	7·64	1·16	..	86	
44	Whotungay	Albizzia ...	1·79	0·266	3·68	1·45	....	91	
45	Tare	Terminalia belerica ...	0·654	0·127	6·95	0·53	...	86	
46	Govarnellu	Bischofia Javanica ...	0·79	0·221	3·66	1·05	...	91	
47	Silver Oak	Grevillea robusta ...	0·76	0·077	0·59	0·38		94	

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Analyses of Fish, Bone, Poonacs, Dried Blood and Prawn Manure.

No.	Substance.	Locality.	Nitrogen.	Phosphoric acid.	Moisture.	Insoluble Residue.	Organic and volatile matter.	Remarks.
2	Fish, dried whole	West Coast	3·96	1·73	28·00	2·71	44·51	
5	Do do	Do	7·61	5·42	5·59	3·48	71·02	
6	Do do milled	Do	6·98	4·75	4·06	7·40	65·54	
7	Do do	Do	8·72	6·12	4·41	9·73	70·21	
8	Do skins do	Do	12·00	3·37	...	...	...	
9	Prawn skins	Do	8·14	...	...	4·47	78·46*	*Moisture and volatile matter.
1	Dried blood	Bangalore	11·55	...	...	...	...	
3	Castor poonac	Do	7·38	...	...	...	...	
10	Hongay poonac	West Coast	3·82	...	..	...	...	
11	Bone meal	Bombay	2·52	18·62	..	13·01	31·3	
15	Bone meal	Bangalore	4·04	23·34	...	2·03	39·42	

Miscellaneous substances.

No.	Substance.	From.	Moisture.	Organic and volatile matters.	Nitrogen.	Insoluble Residue.	Iron and Aluminium oxides.	Lime.	Phosphoric acid.	Potash.	Remarks.
32	Ashes	Central Distillery, Bangalore ...	4·53	28·94	...	24·40	7·56	29·04	1·45	1·97	Partially leached.
25	Lime stone	Kadur District ...	0·84	...	..	7·34	3·04	48·66	...	...	
26	Lime	Do do ...	0·87	...	...	21·46	7·75	41·58	...	...	Used for manurial purposes.
28	Lime	Do do ...	0·96	...	...	27·94	4·41	37·45	...	..	Do
27	Tank soil	Oossur Estate, Hassan District.	9·09	55·11	1·36	24·98	11·47	0·64	0·14	...	